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PRELIMINARY TESTS OF
BACILLUS THURINGIENSIS BERLINER
ON GREAT BASIN TENT CATERPILLAR

By

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INTRODUCTION

Recently a microbial type insecticide has been released for widescale experimental field testing. The material used in this test goes by the trade name of Thuricide and was provided by Stauffer Chemical Company.

Thuricide consists of viable spores of the bacterium Bacillus thuringiensis Berliner in an inert carrier. The fact that this material is a microbial or "living" insecticide sets it apart from chemically synthesized compounds. Two formulations are available: dust and wettable powder. This study was conducted with a wettable powder containing 3 billion spores per gram.

Microbial insecticides greatly minimize the hazards associated with chemically formulated materials since they usually have a low toxicity to man and other warmblooded animals, birds, fish, and plants. B. thuringiensis is specific in its lethal action in the case of the species of insects that are susceptible. This means that associated predator-parasite populations are relatively unharmed by the application of this material.

The study was conducted in the vicinity of Zion National Park, Utah, where past records show populations of defoliating insects have caused severe damage to a wide variety of broad-leaved trees and shrubs.

The Great Basin tent caterpillar, Malacosoma fragilis (Stretch) was the only defoliator found in sufficient numbers to allow tests of the bacterium in the spring of 1959. On April 21, four different dosages of Thuricide were applied to foliage immediately surrounding tents of second- and third-instar caterpillars. Dosages approximated .5, 1, 2, and 4. lbs. of wettable powder per acre. The host plant was serviceberry, Amelanchier utahensis Koehne.

MATERIALS

Pressure sprayer: A self-contained air supply, hand-held sprayer, similar to those used in service stations for cleaning windshields was used (fig. 1). All spraying was conducted at a starting pressure of 50 p.s.i. and 100 milliliters of each dosage was used per individual application.

Cages: Cages made of flexiglas and saran screen were used to enclose tents of the forest tent caterpillars. These cages were of the cylindrical sleeve type (fig. 2).

METHODS

Four different dosages of the bacterium were applied. The number of spores per ml. per dosage level were calculated as follows:

6.4 oz. Thuricide = 181.4 grams. This amount of wettable powder, when mixed with 1,000 milliliters of water, gave the equivalent of 4 lbs per acre suspension. From this stock 2, 1, and .5 lbs per acre suspensions were made by a series of progressive dilutions as follows:

1. 181.4 g. Thuricide = 4 lbs/A = 544,200,000 spores/ml.
1,000 ml. distilled H₂O.
2. 500 ml. Thuricide suspension 1 = 2 lbs/A = 222,100,000 spores/ml.
500 ml. distilled H₂O.
3. 250 ml. Thuricide suspension 2 = 1 lb/A = 136,500,000 spores/ml.
250 ml. distilled H₂O.
4. 175 ml. Thuricide suspension 3 = .5 lbs/A = 68,250,000 spores/ml.
175 ml. distilled H₂O.

Forest tent caterpillar populations were located on serviceberry bushes and spray applications were made in the following manner.

One hundred ml. of a given dilution was placed in the spray tank and the pressure brought to 50 pounds per square inch by using a hand-actuated tire pump. All foliage surrounding a tent was sprayed in amounts approximating one gallon per acre.

Two replications of each dosage were made and immediately after spray was applied sleeve cages were slipped over the sprayed tent and infested foliage. Care was taken to include enough treated foliage to insure uninterrupted feeding throughout the test period. Cages were tied off at the top and bottom with nylon cord to prevent the caterpillars from escaping.

Two check cages were established in the immediate vicinity of sprayed bushes. Observations and collections were made at about 3-day intervals and mortality was recorded for each cage. At the time of the first observation some difficulty was experienced in collecting dead caterpillars. The insects had fallen into the wrinkled conical bottoms of the cages and were hard to retrieve. The situation was overcome by tying the lower saran screen portion of the cage up close to the flexiglas (fig.3). This provided a "platform" on which the dead caterpillars fell and from which they could be easily collected.

RESULTS

It was possible, by caging, to maintain "captive" populations of caterpillars in each treatment and check series.

Progressive mortality was recorded at each observation period and accumulative mortality calculated by subtracting the total known number of dead caterpillars from final live plus dead counts.

Populations varied from cage to cage as follows:

Table 1.

	<u>Dosage lbs/A</u>				
<u>Replications</u>	0.5	1.0	2.0	4.0	Check
	<u>Individuals per cage</u>				
A	39	19	12	49	63
B	17	43	58	88	42

Mortality counts were made during 6 observational periods between April 23 and May 25. Accumulative mortality counts for each date at each dosage level is given in table 2.

Table 2.--Average cumulative mortality for both replications

<u>Date</u>	<u>Dosage</u>				
	0.5	1.0	2.0	4.0	Check
4/23	2	5	6	9	1
4/26	13	32	6	21	1
4/30	77	92	59	100	1
5/3	84	92	73	-	4
5/11	84	94	86	-	4
5/25	<u>97</u>	<u>96</u>	<u>92</u>	<u>-</u>	<u>12</u>
% Total mortality	97	96	92	100	12

The foregoing mortality percentages represent the average kill in each dosage. Table 3 (appendix) presents a separate breakdown of individual replications and exposures; sunlighted cages as compared with shaded cages.

Due to random placement, all dosage levels except the 2.0 series had one cage in open sunlight and the other shaded. The degree of shading varied from light to heavy during the course of sunlight hours.

The 4.0 lb dosage produced the greatest mortality in both replications (sunlighted and shaded) and reached 100 percent in 10 days. This significant difference can be seen in table 3. All sunlighted cages had a higher mortality than did shaded cages sprayed with the same dosage.

After the 13th day no significant mortality was recorded except in the cages sprayed with the 2.0 lb. dosage. It should be noted that both of these replications, by random placement, were in shady locations. It is suspected that this could account for a lag in the killing action of the bacterium because feeding was slower in shaded cages, consequently the rate of spore ingestion was reduced. Without exception, visual observations showed that feeding activity occurred at a slower rate in the shaded cages as opposed to sunlighted cages.

The following percentages of control were arrived at by applying Abbott's formula which allows for mortality occurring in untreated check populations.

Dosage in lbs/A	0.5	1.0	2.0	4.0
% control	96.5	95.4	90.9	100.0

DISCUSSION

Killing action of Bacillus thuringiensis Berliner is largely dependent upon a given number of bacterial spores being ingested per milligram of insect body weight. Research done by other workers has determined the minimum lethal dose to be 450 viable spores per milligram of insect body weight. These facts are being pointed up because of mortality variations that occurred between the .5, 1, 2, and 4 lb. dosages.

Visual observations throughout the study period showed that feeding was consistently heavier and more rapid in unshaded sunlighted cages. Caterpillars in these cages ingested more foliage during the test period and consequently more spores than did those in shaded cages. This undoubtedly was the reason that mortality in both replications of the 2 lb. dosage lagged behind the other 3 dosages. It appears that open sunlighted areas with approximately the same height vegetative cover would require smaller dosages of B. thuringiensis than shaded, uneven, overstoried areas.

Another finding of this study was that on surrounding untreated foliage defoliation proceeded unchecked. In sharp contrast, feeding activity in the treated cages was noticeably slowed down within 3 days. This can probably be attributed to the fact that the bacterium acting on the larvae slowed down their over-all physiological processes rather rapidly, which in turn retarded feeding activities. Results obtained with B. thuringiensis in this preliminary study warrant expanded tests to develop procedures for treatment of large areas.

A P P E N D I X



Figure 1. Hand held, self-contained air supply pressure sprayer.



Figure 2. Flexiglas and saran screen cages for confining populations of Great Basin tent caterpillar.



Figure 3. Cage showing method of tying saran screen up close to flexiglas to form a platform on which dead caterpillars fall. This procedure greatly facilitated collection operations.

TABLE 3 COMPARISON OF FOUR DIFFERENT DOSAGES OF
B THURINGIENSIS BERLINER SHOWING PERCENT
ACCUMULATIVE MORTALITY



